

# **Report for 2001KY2781B: Bacterial ratios and neural networks for modeling Kentucky River water quality**

- Conference Proceedings:
  - Brion, G.M. and S. Lingireddy, 2002, Artificial Neural Network Modeling: A Summary of Successful Applications Relative to Microbial Water Quality, in Proceedings Joint CSCE/EWRI Environmental Conference, Niagara Falls, Canada, July 2002.
  - Nieman, J. and G.M. Brion, 2002, Novel Bacterial Ratio to Predict Fecal Age, In Proceedings Joint CSCE/EWRI Environmental Conference, Niagara Falls, Canada, July 2002.
  - Brion, G.M., T.R. Neelakantan, and S. Lingireddy, 2001, New Tools to Define the Impact of Stormwater on Receiving Surface Waters, in Proceedings ASCE Environmental Water Resources Institute Congress, Orlando, Florida, May 2001.
  - Brion, G.M., and S. Lingireddy, 2002, Artificial Neural Network Modeling: A Summary of Successful Applications Relative to Microbial Water Quality, in Proceedings 3rd World Congress of the International Water Association, Health-Related Water Microbiology Symposium, Melbourne, Australia, April.
  - Neiman, J. and G.M. Brion, 2002, Novel Bacterial Ratio for Predicting Fecal Age, in Proceedings 3rd World Congress of the International Water Association, Health-Related Water Microbiology Symposium, Melbourne, Australia, April.
- Dissertations:
  - Neiman, Jonathan , 2002, Novel Bacterial Ratio for Predicting Fecal Age, MS Thesis, Department of Civil Engineering, University of Kentucky, Lexington, KY.

**Report Follows:**

## **Problem and Research Objectives**

Our nation's rivers as well as our local water supply the Kentucky River are overburdened with pathogen indicators, and presumably pathogens. Existing indicator systems fail to identify the source and age of fecal contamination thereby limiting their usefulness as risk assessment tools. Watershed managers, water utilities, public health microbiologists, and regulators need new indicator systems; systems that provide more specific information about fecal contamination to assess the pathogen risk in source water and implement changes to management practices and/or treatment methods when required. The Kentucky American Water (KAW) Company is one of the few facilities that has monitored their intake for a range of bacterial indicators. The database KAW has kept is incomplete, with the peak numbers of bacteria often missing due to inadequate dilution. Published research by the PIs has proven using multi-parameter databases and advanced neural network programming can predict peak microbial concentrations. The main objective of this research is to backfill the missing data in the KAW database, which is crucial for developing reliable indicator systems.

## **Methodology**

A feed-forward neural network will be trained on historical but complete (those with no missing/incomplete records) observations from KAW database to predict a range classification for a single parameter from the other available parameters. Once trained, the model will be asked to predict the range of concentration of bacteria for the missing observations based upon the pattern and interrelationships it has learned between other water quality parameters (pH, alkalinity, turbidity, etc.) The neural network model predictions for bacterial concentrations will be checked against the results of the simultaneous laboratory survival studies and new data from KAW collected during spring, summer, and early fall peak events.

## **Principal Findings and Significance**

In addition to providing further insight into the abilities of neural network models in classifying fecal contaminant sources and in backfilling missing data, the research is expected to strengthen the previous findings on bacterial ratio (Atypical Coliforms/ Total Coliforms or AC/TC) as a reliable indicator of age of fecal source. Principal findings reported at conferences triggered interest in this research and have resulted in collaboration with two International groups: 1. Department of Microbiology, University of Barcelona, and 2. Institute of Environmental Science & Research Limited, Christchurch Science Center, NEW ZEALAND, of which the second group has already confirmed our research findings on AC/TC ratios on one of their databases.